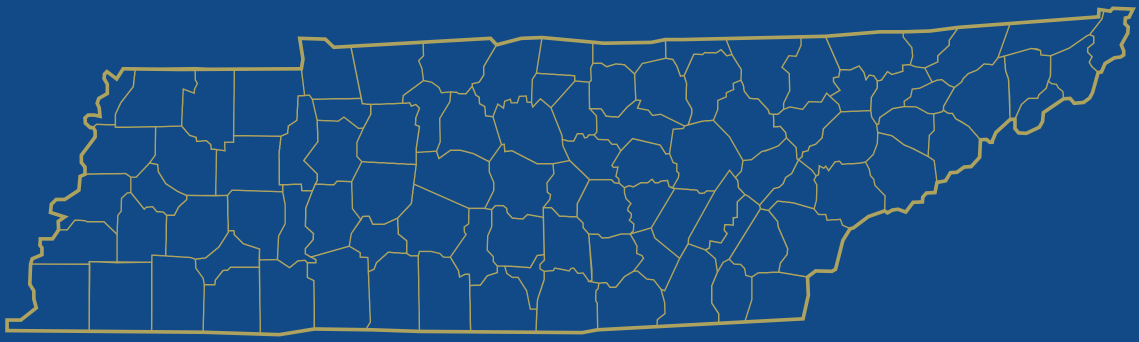
CONNECTING TENNESSEE



Bridging THE Digital Divide

Prepared by the
Tennessee Regulatory Authority
and
Tennessee Department of Education

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June 2001

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Executive Summary

Connecting Tennessee: Bridging the Digital Divide

During the 2000 session of the 101st Tennessee General Assembly, members of the Tennessee House of Representatives passed a resolution directing the Tennessee Regulatory Authority (TRA) to research and develop a program that provides Tennessee school-aged children access to information-based technology tools and advanced technologies. Resolution 273 is attached as Appendix A. This resolution was in response to a report issued by the TRA in May of 2000 titled, *"Tennessee's Digital Divide."* In that report, using data compiled from the Census Bureau's 1998 Population Survey, we found that the digital divide – defined as the gap between those with access to computers and the Internet and those without - was more prevalent in Tennessee than in the rest of the nation. The information showed that only 37.5 percent of Tennesseans reported having personal computers compared to 42.1 percent nationally, and that 21.3 percent of Tennessee households reported having Internet access compared to 22.2 percent for the rest of the nation.

To get a more current view of how the state's residents have progressed since 1998, this report relies upon data collected from a TRA commissioned survey of Tennessee school-aged children and the households in which they reside. The survey was conducted by researchers at the University of Tennessee at Knoxville, and included the responses of more than 1,000 Tennessee households with school-aged children. The results were eye opening. The collected data showed that Tennessee, like the rest of the country, still has measurable differences in levels of access to technology-based information among different groups of school children. These differences are based on such factors as race, household income, population density of the area in which the household is located, and educational attainment of the head of the household. The results also revealed, however, that Tennessee appears to be ahead of many other states in providing access to computers and the Internet to children at school. Moreover, the survey results showed that Tennessee students enjoy higher rates of both computer and Internet access at school than do students nationwide. Although in-school access has helped close the digital divide somewhat in Tennessee, there are still substantial numbers of Tennessee school children that do not have access to information technology in any location. One area of concern is the educational impact on students who are without access to computers and the Internet. Examples abound of school children in the U.S. and abroad utilizing advanced technology as an educational tool. Within this report the reader will learn of the Computer-Supported Intentional Learning Environment (CSILE, pronounced *cecil*), a project involving two elementary school classes in two different continents separated by the ocean, but linked educationally by the Internet. In addition, the report includes information about the Global Learning and Observations to Benefit the Environment (GLOBE) program, an initiative that currently links over 3,500 schools around the world to scientists. The program teaches students how to apply scientific concepts in analyzing authentic environmental problems.

Although no rigorous evaluations of the effects of utilizing computers and the Internet on learning have been conducted, those students with access to information technology seem to enjoy a much richer educational experience than their counterparts in environments where advanced technologies are absent.

In conclusion, this report to the Tennessee General Assembly explores the nature of Tennessee's digital divide, and the potential implications of not addressing current inequalities in access to advanced technologies. The report, furthermore, looks at the efforts that have already been made in Tennessee to close gaps among groups in access to technology, and possible future programs aimed at eliminating these gaps. This report provides a brief analysis of the pros and cons of implementing digital divide programs in the three key access points: in school, in home, and in community centers. As directed by House Resolution 273, the report focuses attention on developing a plan for implementing a digital divide pilot program aimed at school-aged children.

What Is The Digital Divide?

In its report entitled "Creating the CyberSouth," the Southern Growth Policies Board defined the digital divide as follows:

> *The inability of some people to participate fully in the new Information Age in ways that ensure equality of opportunity in social, educational, political, and economic systems.*[1]

While many people tend to think of the digital divide solely in terms of Internet access, there are four (4) major areas of concern among researchers:

1) Access to Information Technology – Does everyone have affordable, readily available access to the Internet? If it becomes necessary to participate fully, will everyone have access to a high-speed Internet connection?

2) Computer Literacy – Does everyone know how to use a computer? Does everyone know how to access the Internet?

3) Information Literacy – Does everyone know how to find information on the Internet? Can people distinguish between reliable and unreliable information?

4) Appropriate Informational Content – Can everyone find information relevant to them on the Internet?

Why Does the Digital Divide Matter?

There are several reasons to be concerned about the emerging gaps in access to and use of information technology.

Economic Development

One of the most obvious is related to job skills. As businesses must increasingly look to overseas workers to fill high-tech positions, the need to upgrade the skills of American workers becomes more apparent. Everyone benefits from a well-educated, well-trained work force. Tennessee routinely recruits large companies to locate in the state, bringing jobs to Tennessee citizens. If Tennessee's work force is

[1] Bohland, James, Maria Papadakis, & Richard Worrall. *Creating the CyberSouth.* Prepared for the Southern Growth Policies Board for Presentation at its Conference "TelecomSouth II: One South, Digitally Divided." September, 2000.

perceived as unable to provide high-tech workers, these businesses may increasingly choose to locate elsewhere.

Civic Involvement

As more information resources are brought online, the digital divide becomes a fundamental issue of equality of opportunity. Last year, Governor Don Sundquist was the first Tennessean to renew his driver's license online. Further, during discussion of his proposed tax cut, President Bush expressed a commitment to moving more government services online. Citing savings in time, paperwork and record-keeping efforts, Bush stated that he believed the Internet was an efficient way to deliver governmental information, make governmental purchases, and provide governmental services.[2] In a possible sign of things to come, a major university announced recently that it will no longer accept paper applications for admission. As more governmental services move to the Internet, those without access will find themselves increasingly disadvantaged in their ability to use such services. While the connected take a few minutes from their lunch hours at work to renew a license, the disconnected will lose half a day's productivity standing in line to accomplish the same task. While the connected register to vote online, the disconnected will have to find out how to register, locate an office, get there, and, again, stand in line. Basic economic theories of demand state that the more an activity or service costs, the less inclined one is to do that activity or purchase that service. While government services may carry the same monetary charge for all, the time and trouble required to take advantage of them is also a cost. The disconnected will find government services and civic involvement cost them more than they cost the connected, and the disconnected will be less inclined to involve themselves in society.

As more governmental services move to the Internet, those without access will find themselves disadvantaged…

In the Consumer Federation of America's report "Disconnected, Disadvantaged, and Disenfranchised: Explorations in the Digital Divide," author Mark Cooper found that the disconnected participate less online than they do offline. This led him to conclude the following:

> *The digital divide is an important policy issue because the Internet has already become a significant means of communication and commerce in society. Households with access use it for important personal, cultural and civic activities while those without access are at a disadvantage in conducting similar daily activities… At the same time that the data document the dramatic difference between participation in physical space and cyberspace, they also show that the difference in participation in cyberspace is not a mere reflection of a lower level of participation… in real space. The disconnected… households do participate a little less in physical space, but not nearly as much less as they do in cyberspace. With the shift of activity to the Internet that has already occurred, and*

[2] The Benton Foundation. *Communications Related Headlines,* March 2, 2001. Available at www.benton.org.

> *the prospect of even more dramatic shifts in the future, the threat that the disconnected are disadvantaged and disenfranchised grows.*[3]

Some policy makers have concluded that the digital divide is just another example of some people having less than other people. There is concern among some that the digital divide is an excuse to create entitlement programs in an area that competition, given adequate time, can and will address. Many policy makers question the notion that access to information technology is simply one more luxury good or a service that can wait for competition to create ubiquity. In a Heritage Foundation report entitled "How Free Computers Are Filling the Digital Divide," author Adam Thierer concluded the following:

> *Is there a digital divide crisis in America? No, there is not. If Americans really want a personal computer and access to the Internet, they can obtain them at very little cost.*
> *Moreover, this trend to lower-cost PCs and more access is likely only to increase. Expensive federal entitlement programs will not facilitate this process; in fact, they might actually make things worse by putting pressure on computer prices to hold steady or increase.*
> *To the extent government involvement is needed, it is to remove any tax and regulatory roadblocks that discourage private companies in the free market from offering new products and services that consumers demand. There is no constitutional or economic justification for federal intervention.*[4]

Educational Opportunity

Bridging the digital divide provides an opportunity to remedy existing differences in student achievement. This country's students leave high school with vastly different levels of education and cognitive skill. The students who seem to learn the most tend to be non-minority, come from higher-income households, and have parents with higher levels of education. Students without these advantages, the same students who lag behind in information technology usage today, can benefit from new approaches to reaching, engaging and teaching children. Cognitive research has shown that learning is most effective when four fundamental characteristics are present: 1) active engagement; 2) participation in groups; 3) frequent interaction and feedback; and 4) connections to real-world contexts.[5]

- Active Engagement

In his studies of knowledge and cognition, Jean Piaget introduced the notion that "children are not empty vessels to be filled with knowledge (as traditional pedagogical theory had it), but active builders of

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[3] Cooper, Mark N. *Disconnected, Disadvantaged, and Disenfranchised: Explorations in the Digital Divide*. The Consumer Federation of America. October 11, 2000.
[4] Thierer, Adam D. *How Free Computers Are Filling the Digital Divide*. Washington, DC: The Heritage Foundation, April 20, 2000.
[5] Roschelle, J. M., Roy D. Pea, C. M. Hoadley, D. N. Gordin & B. M. Means. "Changing How and What Children Learn in School Using Computer-Based Technologies." *The Future of Children*, Vol. 10, No. 2, Fall/Winter 2000, p. 76–101.

knowledge - little scientists who are constantly creating and testing their own theories of the world."[6] Piaget's ideas were built on earlier thoughts on democracy and education put forward by John Dewey:

> *To "learn from experience" is to make a backward and forward connection between what we do to things and what we enjoy or suffer from things in consequence. Under such conditions, doing becomes a trying; an experiment with the world to find out what it is like; the undergoing becomes instruction - discovery of the connection of things.*[7]

Most educational reformers agree that more attention should be given to actively engaging children in the learning process. Curricula have evolved to a point that students are expected to take active roles in solving problems, communicating effectively, analyzing information, and designing solutions; skills that go far beyond the mere recitation of correct responses. Although active, constructive learning can be integrated into classrooms with or without computers, the characteristics of computer-based technologies make them a particularly useful tool for this type of learning. They enable the creation of reports, drawings and images; they store, index, cross-reference and present vast amounts of current information; they are suitable for teacher-driven, directed learning as well as student-driven, unstructured exploration; they blend multiple artistic disciplines (text, image, sound); and they allow students and teachers to collaborate with peers, parents and experts from all over the world.

Students involved in the Vermont Millennium Arts Project compose music online. Professional composers, teachers, and other students evaluate their original compositions via e-mail. After a few months of suggestions and revisions, the young composers who wish to do so present their compositions using musical instruments in a recital. Vermont students are producing original melodies with complex rhythms and elaborate harmonies. Their pieces employ a range of instruments and are distinguished both by their originality and surprising sophistication. "Some of the work these kids are doing is amazing," says Peggy Madden, a professional composer who corresponds with some of the students. "And they continue to get more amazing: the kids come back and put up new compositions each year that are better than the ones they did before."[8]

- Participation in Groups

The ideas behind group activity in learning are articulated in the works of Russian psychologist Lev Vygotsky, noted for his research and theories dealing with the development and structure of human consciousness. Vygotsky contributed the idea that there is a difference between what a child can do on her own and what a child can do with help. Cognitive development results when a child learns through

[6] Papert, Seymour. "Child Psychologist Jean Piaget." *Time 100: Scientists and Thinkers,* TIME, June 17, 2000.
[7] Dewey, John. *Democracy and Education,* New York, NY: McMillan and Company, 1916.
[8] United States Department of Education. *E-Rate and the Digital Divide: A Preliminary Analysis from the Integrated Studies of Educational Technology*, September, 2000.

problem-solving experiences shared with someone else, usually a parent or teacher but sometimes a sibling or peer.[9]

Performing a task with others provides an opportunity not only to discuss the task but also share ideas about the best ways to approach the task and clarify one's own thinking on the subject by defending it in a group. Because a child's social identity is enhanced by participating in a community or by becoming a member of a group, involving students in a social intellectual activity can be a powerful motivator and can lead to better learning than relying on individual desk work.[10]

Some critics contend that computer technology encourages antisocial and addictive behavior and taps very little of the social basis for learning. Several computer-based applications, such as tutorials and drill-and-practice exercises, do engage students individually. Projects that use computers to facilitate educational collaboration, however, span nearly the entire history of the Internet, dating back to the creation of electronic bulletin boards in the 1970s. Some of the most prominent uses of the computer today are communications-oriented, and networking technologies, such as the Internet and digital video, permit a broad new range of collaborative activities in schools.[11]

The Computer-Supported Intentional Learning Environment (CSILE, pronounced *cecil*) Project links two elementary school classes, one in northern Canada and one in rural Scandinavia. Students engage in library research and real-world experimentation, overseen and directed by teachers, to come up with scholarly research questions. As the students pursue their research, they put their ideas, questions and findings into the CSILE software system as notes and share them with their peers across the ocean. The notes are classified into types of thinking such as "My theory for now…" or "What I need to know next is…" Through the prompting of these different categories, their teachers' guidance, and the critique and questions of their distant peers, students support and refine their ideas online. The students express their ideas both in text and in graphics, and, in this case, students use a mix of languages: English, Inuit, and Finnish. Not only does their understanding of the research topic improve, they also gain valuable writing and language skills and a better multicultural understanding.[12]

- Frequent Interaction and Feedback

Research suggests that learning proceeds most rapidly when learners have frequent opportunities to apply the ideas they are learning and when feedback on the success or failure of an idea comes almost immediately.[13] Unlike other media, computer technology supports this learning principle in three ways:

[9] "Vygotsky and Social Cognition." Funderstanding: The Coolest Kids' Site, The Hottest Kid Insight. Available at www.funderstanding.com/vygotsky.cfm
[10] Vygotsky, L.S. *Mind in Society*. Cambridge, MA: Harvard University Press, 1978.
[11] Roschelle, J. M., Roy D. Pea, C. M. Hoadley, D. N. Gordin & B. M. Means. "Changing How and What Children Learn in School Using Computer-Based Technologies." *The Future of Children*, Vol. 10, No. 2, Fall/Winter 2000, p. 76–101.
[12] Roschelle, J. M., Roy D. Pea, C. M. Hoadley, D. N. Gordin & B. M. Means. "Changing How and What Children Learn in School Using Computer-Based Technologies." *The Future of Children*, Vol. 10, No. 2, Fall/Winter 2000, p. 76–101.
[13] Anderson, J.R. *The Architecture of Cognition*. Mahwah, NJ: Lawrence Erlbaum Associates, 1996.

1) computer tools encourage rapid interaction and feedback; 2) computer tools can engage students for extended periods on their own or in small groups, allowing time for the teacher to give feedback to particular students individually; and 3) computer tools can be used to analyze each child's performance and provide more timely and targeted feedback.

In one version of computer-assisted feedback, a program called Diagnoser traces students' reasoning process, step by step, then provides teachers with suggested remedial activities based on areas in which each individual student is confused. Data from experimental and control classrooms showed scores rising more than 15% when teachers incorporated use of Diagnoser. Results from use of applications based on this approach to teach math skills showed students making small gains on standardized math tests and nearly doubling their achievement in complex problem-solving.[14]

- Connections to Real-World Contexts

Rote memorization does not give a student the ability to identify a situation in which this knowledge would be relevant. Without mastering underlying concepts through actual applications of knowledge, many students are unable to convert classroom knowledge into real-world knowledge.[15] Computer technology allows students to apply concepts to a variety of problems, thereby breaking the artificial isolation of school subject matter from real-world situations. Through Internet connections, students have access to the latest scientific data, whether from a NASA mission to Mars, an ongoing archaeological dig in Mexico, or a remotely controlled telescope in Hawaii. Technology brings opportunities for students to learn through interaction with professionals in every field. Through the Internet, students from around the world can work as partners to scientists, business people, and policymakers.

Through the Internet, students from around the world can work as partners…

The Global Learning and Observations to Benefit the Environment (GLOBE) Program provides an example of the type of directed scientific learning students take part in through computer-based technology and the Internet. Begun in 1992 by then Vice President Al Gore, GLOBE is an innovative program aimed at studying the environment and helping students learn science. Students go out into their communities and gather environmental data pertinent to their research questions, and those data are given to scientists. The scientists then provide guidance about how to apply scientific concepts in analyzing the data and creating solutions for real-world environmental problems. The program currently links over 3,800 schools around the world to scientists, engaging students in learning as they aid real scientific

[14] Koedinger, K.R., J.R. Anderson, W.H. Hadley, et al. "Intelligent Tutoring Goes to School in the Big City." *International Journal of Artificial Intelligence in Education*, Vol. 8, No. 30, 1997, p. 43.
[15] Bransford, J.D., A.L. Brown and R.R. Cocking, eds. *How People Learn: Bra in, Mind, Experience and School.* Washington, D.C., National Academy Press, 1999.

research through their data collection and analysis. In a 1998 survey, 62% of teachers using the GLOBE Program reported that they had students analyze, discuss, or interpret the data. Although no rigorous evaluations of effects on learning have been conducted, surveyed GLOBE teachers said they view the program as very effective and indicated that the greatest student gains occurred in the areas of observational and measurement skills, ability to work in small groups, and technology skills.[16]

Other Findings

The United States Department of Education reviewed the existing literature on the use of computers in the classroom in its report "E-Rate and the Digital Divide: A Preliminary Analysis from the Integrated Studies of Educational Technology:"

> *Most research on the use of computers in education is based on work done during the early days of primarily "drill and practice" and computer-assisted instruction. Reviews of hundreds of such studies have generally concluded that certain types of software for narrowly prescribed basic skills instruction can raise student achievement test scores over time… [M]uch of the earlier research on educational technology also found that students were reported to learn more quickly and with greater retention when learning with the aid of computers, and that their attitudes toward learning and school were positively affected by the use of the computer for instruction.*

Attempts to study the more modern uses of computers have, however, been limited and often plagued by weak research methods, particularly a lack of adequate comparison groups. Examples of recent works include the Apple Classrooms for Tomorrow Project, implemented in hundreds of classrooms, that reported positive effects on student attitudes and motivation… [C]ase studies of modern technology in very disadvantaged schools… found higher levels of teacher-reported increases in student motivation and learning. The Center for Applied Special Technology reported positive effects on student learning from the increased availability and use of the Internet for classroom instruction. Finally, [a study of] West Virginia's Basic Skills-Computer Education program [examined] the progress of 950 fifth grade students in eight schools. According to the authors, the use of technology to improve students' basic skills in reading and math resulted in small positive increases in test scores, especially for rural and low-income children.[17] A more detailed listing of major computer-assisted learning program evaluations is provided in summary form in Appendix B.

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[16] NOAA National Geophysical Data Center. *GLOBE Year 3 Evaluation*. 1999. Available online at www.globe.gov/sda-bin/wt/ghp/y3eval+L(en).

[17] United States Department of Education. *E-Rate and the Digital Divide: A Preliminary Analysis from the Integrated Studies of Educational Technology*, September, 2000.

How Serious is the Problem?

The U.S. Department of Commerce provided new digital divide information, gathered in August 2000, in its report "Falling Through the Net: Toward Digital Inclusion."[18] Nationally, the gap between households in rural areas and households nationwide that access the Internet has narrowed from 4 percentage points in 1998 to 2.6 percentage points in 2000. Rural households moved closer to the nationwide Internet penetration rate of 41.5%. In contrast to this strong growth, households in central cities have experienced much slower rates of increase for their Internet penetration. In August 2000, 37.7% of central city households had Internet access. The gap between these households and the national average has increased by 2.1 percentage points since 1998.

Americans at every income level are connecting at far higher rates from their homes, particularly at the middle-income levels. Internet access among households earning $35,000 to $49,000 rose from 29% in December 1998 to 46.1% in August 2000. Today, more than two-thirds of all households earning more than $50,000 per year have Internet connections. On the other end of the spectrum, households with incomes below $15,000 per year are increasing their Internet access penetration rate more slowly. The divide between these households and higher income households is on the rise, especially in rural areas.

Internet access has increased for households headed by members of all levels of educational attainment, but those with less than a high school degree or only a high school degree are growing more slowly than those headed by members with some college or more education. The gap between households headed by a member with less than a high school education and those headed by a member with a high school diploma increased by 6.9 percentage points between December 1998 and August 2000. Additionally, the gap between households headed by a member with a high school degree and those headed by a member who has had some college increased by 5.2 percentage points during the same time period.

While African American and Hispanic households have seen large increases in Internet access penetration rates over the last two years, the gap separating them from white households increased slightly over that time period. The increase in this gap between white and minority households is growing more rapidly in rural areas. Differences in income and education do not fully account for the gaps between white households and Hispanic and African American households. Households of Asian Americans and Pacific Islanders have maintained the highest Internet penetration rate at 56.8% in 2000.

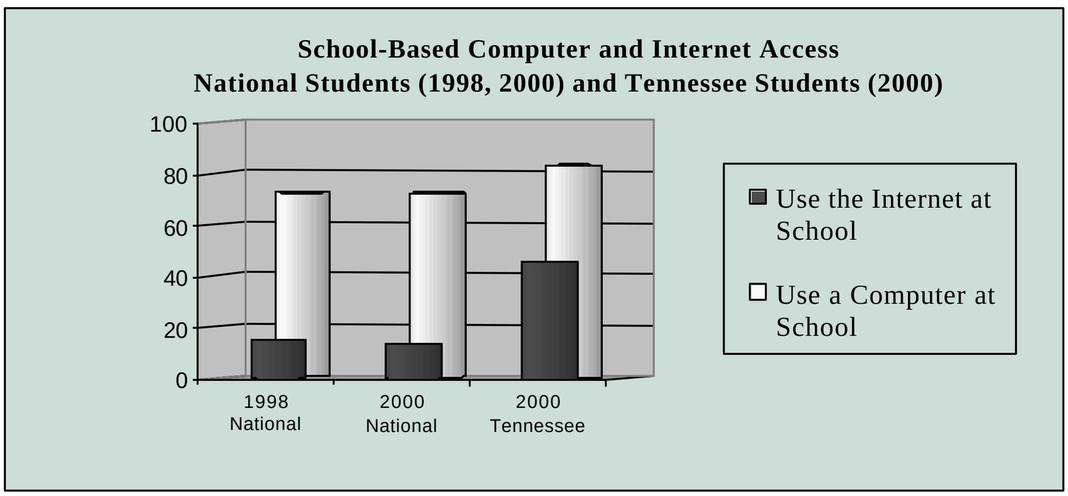
Individuals 50 years of age and older are among the least likely to be Internet users, with a use rate of only 29.6% in 2000. Individuals in this age group, however, were almost three times as likely to be Internet users if they were in the labor force than if they were not.

The Digital Divide in Tennessee

In response to the Tennessee legislature's request for a pilot program to address the digital divide among Tennessee schoolchildren, the Tennessee Regulatory Authority (TRA) commissioned a survey of Tennessee households to determine the dynamics of the digital divide problem in this state. Responses were gathered from 2,037 Tennessee students in 1,200 households during the last quarter of the 2000 calendar year.[19] The data reveal that, while Tennessee exhibits many of the same technology access gaps as the nation as a whole, there are some important differences in the nature of Tennessee's digital divide as compared to the national digital divide.

Tennessee students report a much higher rate of computer and Internet access at school than do students nationally.

One of the most notable results is that Tennessee students report a much higher rate of computer and Internet access at school than do students nationally. The following graph shows a comparison of school-based access for students nationwide in 1998 and 2000 and for Tennessee students in 2000.



On its web site, the Tennessee Department of Education reports the following concerning its efforts to connect Tennessee classrooms to the Internet:

> *Through the Sundquist Administration's ConnecTEN program, Tennessee was the first state to connect all of its public schools and libraries to the museums, libraries and databases available on the World Wide Web. The state is now bringing Internet resources into every public school classroom by networking school computers. Fifty thousand classroom computers are already connected to the Internet.*[20]

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18 United States Department of Commerce. *Falling through the Net: Toward Digital Inclusion*, October 2000.
19 An explanation of survey methods is presented in Appendix C. The survey is available on the TRA web site at www.state.tn.us/tra

Approximately 145,000 Internet-connected computers have been placed in Tennessee schools – one for every six or seven students if computers were uniformly distributed. All classrooms have at least one computer connected to the Internet. School access alone, however, may not provide school children with enough time to explore the Internet fully and learn to make use of all of its informational and educational possibilities. A recent report on WSMV News pointed out some of the problems faced in individual schools and classrooms when it comes to making use of technology:

> *In Clarksville High School, 1800 students wait to use the 10 computers in the school's library. And in most classes, the teacher's computer is the only one in the classroom.*[21]

Additional anecdotal evidence from Tennessee students suggests that the Clarksville High School experience is not an isolated one. The level of access to information technology enjoyed by Tennessee students is not currently known. The Tennessee Department of Education has a study underway to determine the amount of time students have access to computers and the Internet and what use they make of that access.[22] As reported above, the total number of computers in Tennessee schools works out to between 6 and 7 students per computer. These numbers do not reflect differences in distribution, however, and some schools are likely to have a much lower student-to-computer ratio while others have a much higher student-to-computer ratio.

The Kaiser Family Foundation reports that, among children who use computers, the average time per day spent at the keyboard is 1 hour, 26 minutes. Children ages 2 – 7 use the computer approximately 40 minutes per day, while children ages 8 – 18 average 1 hour, 41 minutes per day.[23] While no one is sure what constitutes adequate or meaningful access, one might set average computer time for computer users as a benchmark. Anecdotal evidence suggests that students who use the computer and Internet only at school do not have the opportunity to access them every day, much less at the average rate of 1 hour, 26 minutes per day. Additional access, outside of school, may be required to allow students to make full use of the advantages that information technology has to offer.

A variety of community computer access centers exist today, including those in public libraries, Boys' and Girls' Clubs, faith-based organizations, and corporate-sponsored centers. As an example of the number of community facilities available, Metropolitan Nashville-Davidson County Libraries offer computer and Internet access in 6 public computer centers: Hadley Park (8 computers), North Branch (2 computers), Pruitt Branch (14 computers, 9 with Internet access), Watkins Park (3 computers), Looby Branch (19 computers), and the new Main Library (approximately 120 computers). Though the level of community center access is for Tennessee students is not currently known, among students answering the

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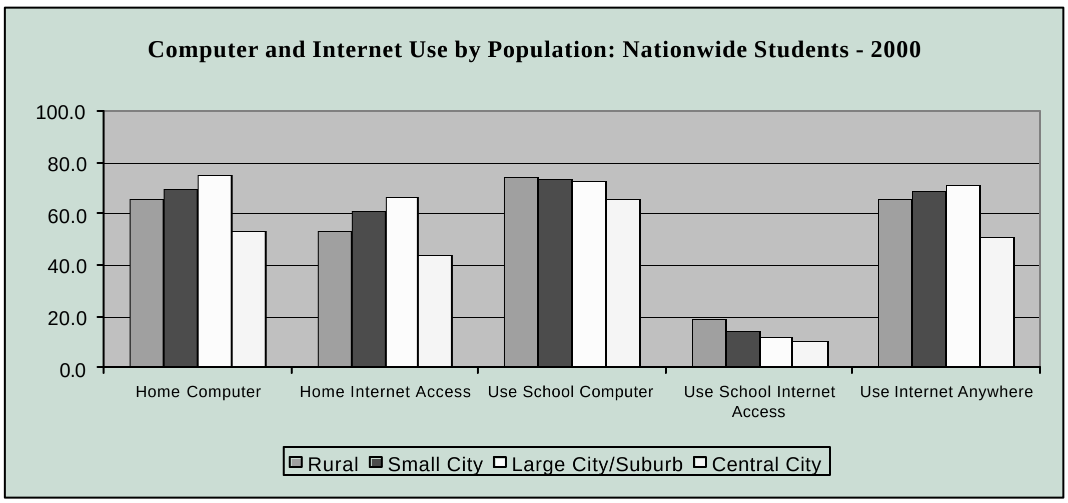
[20] *www.state.tn.us\education\initiatives*

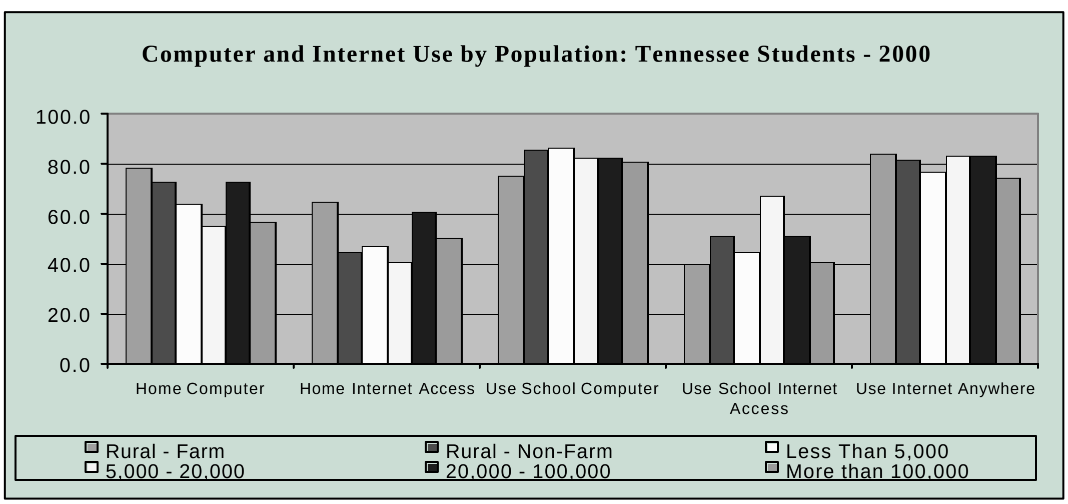
[21] Lewis, James. "Students Could Suffer From Budget Crisis." WSMV News Channel 4. May 3, 2001. *www.wsmv.com/global/Default2.asp?P=/Global/category=asp?C=6026&nav=ITcT*

[22] If reliable data from the study reveals that the level of access to computers and the Internet at school by Tennessee's students has reached or surpassed a level that can be accurately and confidently characterized as meaningful, such information would aid in determining the necessity, or size and target, of an ongoing program after the pilot period.

TRA survey, 42.8% reported having access to a computer somewhere other than at home or at school, while 35.2% reported actually using that computer access. 31.7% reported having access to the Internet somewhere other than at home or at school, while 26% reported actually using that Internet access. Even among those with access to public computing facilities, transportation to and from those facilities is not always available.

Though Tennessee has achieved a higher level of school access than many states, divisions among identifiable groups in the levels of all types of access, school, home and elsewhere, still exist in the state. Gaps in computer and Internet access have commonly been found among people of different races, household income levels, head of household educational attainment levels, and community population densities. A look at the TRA survey data shows that these gaps exist in Tennessee as well as nationally.

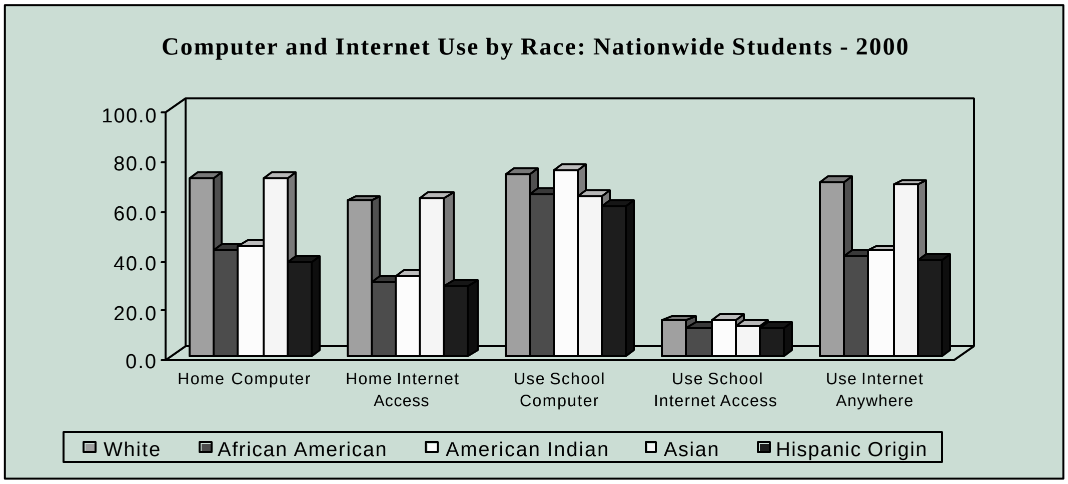




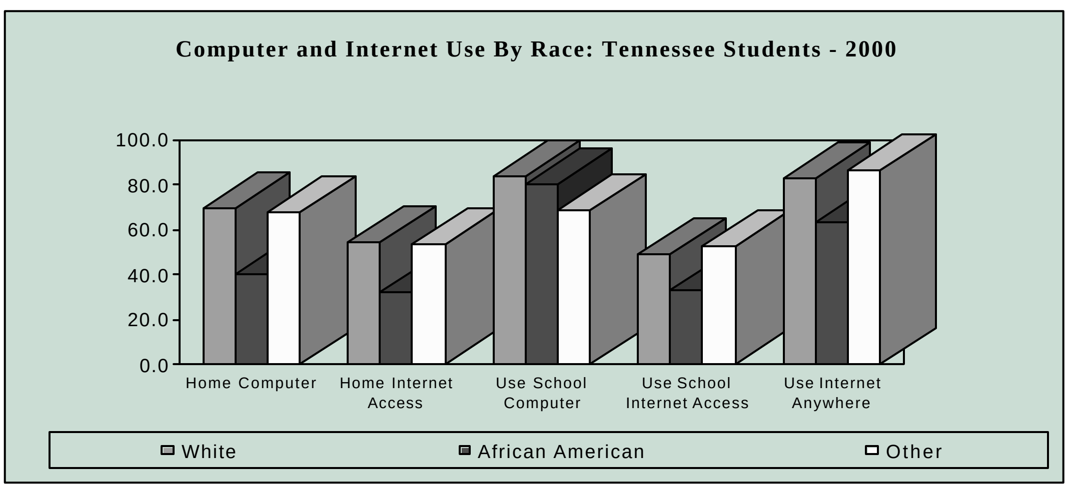
While the access gap among students who live in rural areas has dissipated somewhat nationally in the past few years, students who live in central city areas still lag far behind. Tennessee's rural areas

[23] *Kids and Media at the New Millennium*, Kaiser Family Foundation, November 1999.

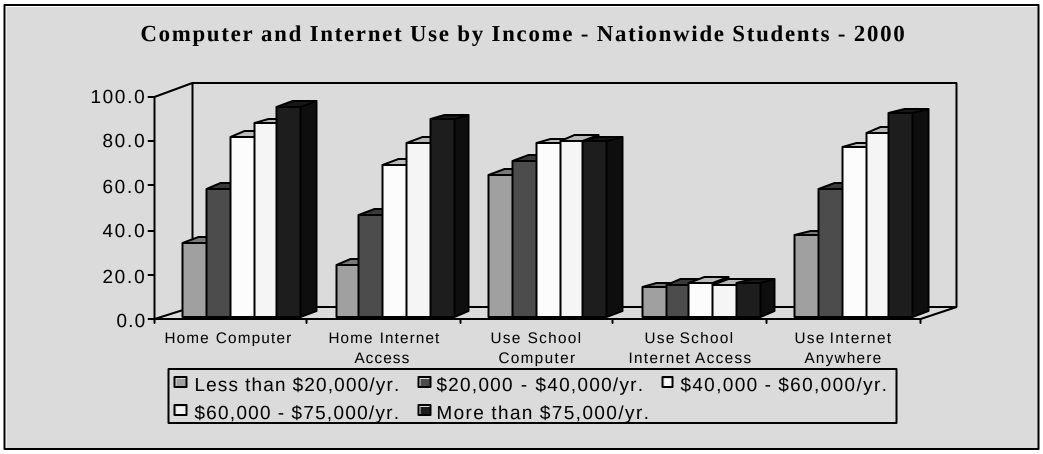
seem relatively well-connected (especially farms), but the state's small city and central city students still have lower rates of access than their rural and suburban counterparts.



Though the higher levels of school computer and Internet access in Tennessee create smaller gaps among those who have ever accessed the Internet and those who have not, home computer and Internet access gaps are as large in Tennessee as they are nationally. School access, while important, may not be all that is required to give meaningful computer and Internet access to school children. The gap in home access between white and African American students is almost identical in Tennessee to that nationally. Though Tennessee has a smaller gap in general (anywhere) access, the racial digital divide still exists in this state. The number of Asian American and American Indian students, as well as of students of Hispanic origin, was too small to separate those groups in Tennessee.

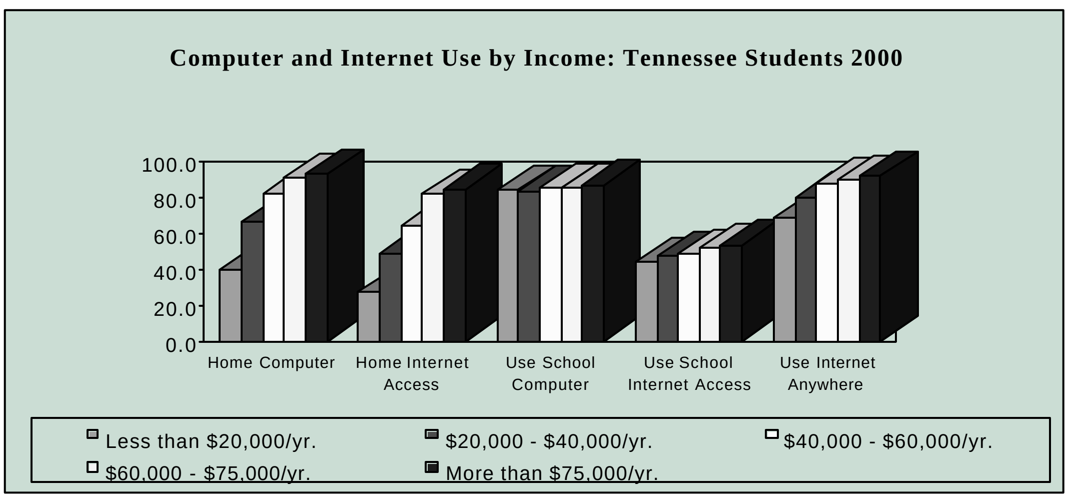


The largest gaps are doubtless among those from households with different levels of income. Not only are lower-income groups less likely to have home computers and home Internet access, they are also less likely to use these technologies at school. These school-based differences are smaller in Tennessee than they are nationally, but they are still noticeable and significant within the state. While use of



computers at school is relatively balanced among children from households of different income levels in Tennessee, use of the Internet at school is less so. A report from the David and Lucile Packard Foundation finds the following concerning disparities in school computer usage:

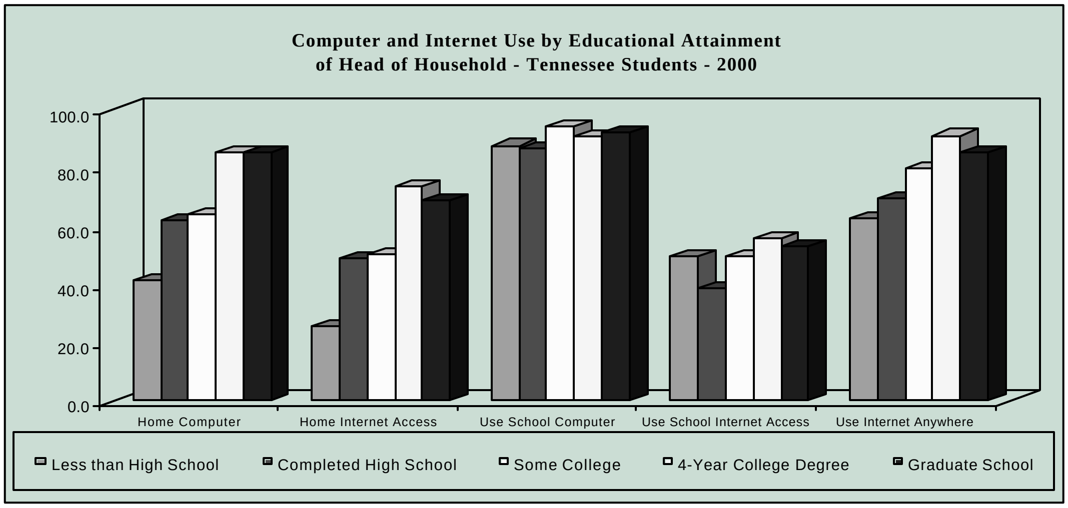
> *Though almost every school in the nation is now wired to the Internet, great disparities are evident in how they use the computers, says the report, which includes studies by several experts. Henry Jay Becker, a professor at the University of California at Irvine, said schools serving poor children were more likely to emphasize word processing and other simple tasks while those serving more affluent students taught computer skills to promote problem-solving and a deeper understanding of an area of study.*[24]



Such differences may explain why, while Tennessee's gap in school computer use among children of different income groups seems to be closed, school Internet access among those same groups of children shows differences along household income lines. In-depth research is more likely to include Internet use than is word-processing. Such research and problem-solving skills are key to the future of Tennessee's children and Tennessee's workforce.

[24] Lewin, Tamar. "Children's Computer Use Grows, but Gaps Persist, Study Says." *The New York Times*. January 22, 2001.

Finally, the educational level of a child's parents is significant in predicting whether or not that child uses computers and/or the Internet. Nationally, this data is not available, as the educational level of the respondent is what was recorded. When the respondent was a school child, as were all of the respondents in the portion of the data we are analyzing, it was that child's educational attainment level that was recorded rather than that of her parents. The TRA survey did record parental educational attainment, however, and those results are shown below.



These basic demographic divisions provide important insight into the nature of the digital divide in Tennessee, but they do not give us the entire picture. One might think that income is the real divide, and that gaps among other groups can be traced to income differences among those groups. The TRA survey respondents are divided into additional subgroups to show that technology gaps exist among different demographic groups, even when income is held constant. Graphs depicting differences in access among students of different races, with parents of different educational levels, and from areas of varying population density for each income group are presented in Appendix D.

How Is Tennessee Addressing the Digital Divide?

Tennessee has several programs in place aimed at reducing the digital divide. The Department of Education has taken full advantage of the Universal Service Fund for Schools and Libraries, commonly known as E-Rate, to help fund the wiring of Tennessee schools. The Metropolitan Nashville/Davidson County Government and the University of Tennessee at Martin both have been recipients of TIIAP grants for programs designed to make online activities more accessible to everyone. The Computers for Homebound and Isolated Persons (CHIPs) program in Knoxville and Oak Ridge provides home computers and Internet access to homebound people. CHIPs was the only project from the United States to win one of 13 international Stockholm Challenge Awards presented to innovative information technology programs in 2000.

These are but a few of the digital divide initiatives in place in Tennessee. Unfortunately, the state does not have a single repository of digital divide program information. As a result, the extent to which the digital divide is currently being addressed in Tennessee cannot be completely known.

What Options Should Tennessee Consider to Address the Digital Divide in the Future?

Digital divide programs generally come in three forms: school access, community center access, and home access. Each type of program generally includes some level of instruction and technical support as well as the requisite hardware and software, but the difficulty involved in providing these products and services varies by type of program. There are advantages and disadvantages to each, and some types are better than others at serving particular populations. Each type has different levels of funding available from various sources.

School Access

Digital divide programs that provide access through schools are aimed at improving education and equalizing access to information technology among students. The E-Rate program has been the greatest source of funding for school-based access nationally, but Tennessee has benefited from several corporate donors as well. By donating computers, teacher training software, and innovative teaching program grants to schools, libraries and non-profits throughout the state, computer manufacturers have shown their long-term commitments to technological literacy in the state.

In school-based programs, instructional and technological support is relatively easy to provide as the computers and access points are centrally located at a school. Students, the target population, can be counted on to come to school most of the time, which minimizes the difficulty they might otherwise have in taking advantage of program benefits.

School-based access is probably a well-deserved first priority in most states, but Tennessee has largely achieved the goal of connecting schools to the Internet. While more computers, more Internet connections, and higher-speed access can still be goals of school access initiatives, other types of programs may be needed to reach the Tennesseans least likely to be connected. Students report a lack of time during school hours to fully explore the Internet or to complete homework assignments using the Internet. Many students may only have access to computers at school once or twice a week, and then only for a limited time. Schools that do not provide regular access to all of their students tend to name a lack of both teacher training and clear educational goals for Internet usage as more immediate problems than a lack of infrastructure.

Community Center Access

The term “community center” is used very broadly in this section. Programs offering community access points are located in schools, libraries, YMCA’s, Boys’ and Girls’ Clubs, and faith-based organizations, to name but a few. Free space for the program is usually the principle guiding the choice of location. Several private businesses have begun to offer funding for community technology access points, most notably a coalition led by America Online (AOL). The AOL program, known as PowerUp, offers hardware, software, and Internet accounts. One PowerUp location in East Palo Alto, California, serves teens who have not only learned to use computers and the Internet, but have begun a successful web design business.

A community center access point is best for serving an entire community, while school or home access may serve as better programs for school children…

Community center programs require less upkeep than home-based programs. Because all of the technology is in one location, instructional and technical support is relatively easy to provide. Community center programs may not be the best choice for school children who already have a limited-use public access point at school. If they are still behind the majority of other school children in technological ability, they may need more time on the computer. A community center access point is best for serving an entire community, while school or home access may serve as better programs for school children.

Home Access

The best predictor of computer and Internet usage is computer ownership. Having a computer with Internet access at home allows one to take all the necessary time to learn how to use the technology as well as how to locate information. In addition, it allows school children to do their homework on a home computer. While school access will benefit a child, home access gives that child a chance to learn to use the technology at her own speed. Other household members who might have never pursued access at a community center also may learn to use the computer if it is in the home.

Several government grants are designed to contribute to innovative programs of any type, though none are targeted at home access. Some cities have set up computer recycling programs to collect donated computers from individuals and businesses who no longer need them, refurbish the computers, and give them to households that do not already own one.

New York set up a home computer program by giving secondhand computers to students on a school-by-school basis through their Knowledge is Power Program (KIPP). Students received the computers at the beginning of the 1999 – 2000 school year. Surveys measuring the effectiveness of the program, conducted in fall of 2000, showed mixed results. About half of the students who received the computers no longer use them at least once a week. Students cited technical problems and the expense of maintaining an Internet account as among the reasons they stopped using their home computers. The remaining students who received the computers continue to use them on a regular basis.[25]

Through their Bridging the Gap program, two schools in the Minneapolis-St. Paul area provided laptop computers to program participants for home and school use. The program stressed information technology training, family computer use with parent/child interaction, linkages for ongoing support and follow-up, and large scale access strategies. Findings showed that 80% of the families beginning the project completed the required 48 hours of training, all students increased their computer competency, students increased their use of computers for both schoolwork and other activities, all parents reported some improvement in their computer skills, teachers reported a high level of motivation among participants, nearly all parents reported understanding the importance of a computer to their children's education, all family members used the computers, weekly parent/child interaction time increased by 75%, test scores for program participants increased relative to those who did not complete the program, absentee rates were not affected, some participants showed an increase in homework completion, parents reported that their children were watching television less and using computers more, and parental school volunteerism and involvement increased.[26]

Any successful home-based computer access program must have a reasonable plan for providing technical support. This can be done either by e-mail or by reporting the problem at school. E-mail mentors, volunteers in most cases, have provided instructional support in some programs. Programs that provide new users, especially children, with mentors to review their work and offer technological guidance have reported high rates of success in training the recipients and motivating them to learn about and use information technology. A coordinated effort between a home-based program and the child's school could make instructional and technical support conveniently available and lead to more successful outcomes over the long term.

[25] Siegal, Nina. "Report Card Mixed on Free Computers for Pupils". *The New York Times on the Web.* January 17, 2001.
[26] Lange, Cheryl M. *Bridging the Gap Evaluation Report.* Lange Consultants. October 20, 1999.

What Should Be Done to Address Tennessee's Digital Divide?

House Resolution 273 (H.R. 273) directs the TRA to research, develop, and formulate a program to facilitate access by underserved school age children to technology-based information tools and advanced technology. The language of the resolution and the discussion surrounding its passage indicate the General Assembly contemplated a program to increase home computer and Internet access. The survey data also indicate a divide in home access. (See figures on pages 10-13.) Wonderful work in school access is being done in Tennessee. There are national models readily available for implementation in Tennessee for community access programs. If a home access program is undertaken, however, there are several factors to consider. Evidence suggests that people require some time and training to master information technology. Since all Tennessee public school students enjoy at least limited access to such technology at school, it seems that the best way to help children who have yet to achieve a working comfort level with computers and the Internet is to place computers in their homes. By working through schools with the lowest levels of students with home access, thereby ensuring adequate support is provided, such a program can help the technology gaps among Tennessee school children. Further, by placing the computers in the homes, the parents of the participating students are also being exposed to the technology. These parents may be interested enough in what the children are doing to learn about the equipment. If the parents see a way the technology fits their lifestyle then they might adopt it. If they do not develop the perception of value they won't, and the divide remains.

As requested, this section outlines a program to place Internet connected computers in the homes of underserved school children. The program is presented in the form of a strategic plan with a vision and mission statement followed by goals and objectives. The specific steps that need to be taken to implement the program are provided as strategies.

The Vision

The vision guiding this proposal is that no one will be left behind as Tennessee moves into the information age. Access to information technology, especially at an early age, will be crucial to success in all walks of life. If some children are not provided technology-based learning opportunities and the ability to develop future job skills at an appropriate age, they will be placed at a disadvantage compared to other children who are provided those opportunities. Not only are individuals affected by this lack of access, but also the overall work force available to potential employers is placed at a disadvantage when compared to other states where greater access to information technology is available. The digital divide is an economic development concern as well as an educational or social concern. If children are left behind in the information age, Tennessee's economy will be left behind with an unskilled workforce.

The Mission

Simply put, the mission expressed in H.R. 273 is to increase access to technology-based information tools and advanced technology by school children who are disproportionately excluded. Access to the Internet is paramount to the future learning capabilities of Tennessee's youth. While other programs aimed at closing the digital divide exist, few have the mission of placing Internet-ready computers in the homes of their target population. Placing computers with Internet access in the homes of underserved Tennessee children will promote closure of Tennessee's digital divide.

Program Summary

Hundreds of computers are replaced on a regular basis in corporate America as well as the government sector. Although not fast or powerful enough for business use, these computers are generally adequate for home use. These machines can be reconditioned and placed in the homes of underserved children. The program will solicit and receive used and new computers and peripherals as well as software and technical assistance for distribution. Several computer and technology firms have provided such hardware, software and services to similar programs, suggesting a general willingness to be good corporate citizens and aid in the education and development of their communities. The success of similar programs elsewhere has depended on follow-up and technical assistance after the computer is placed in the home. The distribution should be focused in classrooms or schools with a teacher or staff member willing to be the first line of support. A knowledgeable teacher or staff member can take care of many technical and training questions, but additional support would need to be available. To assure the adequacy of this type of assistance, the Department of Education should help to identify potential schools and classrooms with willing teachers/staff and a large proportion of students in the underserved population. The computers will have a much greater impact if they are part of an educational program.

Goal

Establish a pilot program to collect new and used computer equipment to distribute to underserved school-aged children while providing Internet access and technical support sufficient to allow increased access to appropriate educational information and technology.

Objective

To place Internet ready computers with the necessary peripherals and support in the homes of one hundred fifty (150) school-aged children.

Strategies

To achieve this objective, the following strategies have been developed:

Strategy #1:

> Partner with the Tennessee Department of Education to select the schools that would benefit from this pilot program based on criteria established from the survey results to provide an access point to the target population.

Methodology to Identify Target Population

The TRA has examined survey data from Tennessee to identify the characteristics of students who would benefit most from participating in a digital divide program. Using school-level data, the Tennessee Department of Education, and the TRA can identify schools with students who face being left behind in a digital age. The demographic variables identified as significant predictors of Internet usage include:

1) Percentage of students who qualify for free and reduced-price lunch programs:

   Qualification for these programs is based on a combination of household income and the number of people in the household. Since a student's household income is not information held by the Tennessee Department of Education, participation in the school lunch program helps to identify schools with large numbers of students from low-income households.

2) Percentage of students who belong to racial minorities:

   Racial minorities generally have lower than average Internet access rates, though some Asian groups have higher than average access rates. Using the percentage of students in the school that belong to each racial group, schools with larger numbers of students at-risk of digital exclusion can be identified.

3) The size of the community in which the school is located:

   Research from several sources shows that both sparsely populated rural areas and low-income urban areas lag behind other communities in Internet access. The type of, and population living within, a community can help pinpoint schools with underserved students.

4) The number of Internet-ready computers per student:

The survey sample would have to include several students from each school for the impact of this variable to be determined. Since the sample is not of sufficient size to allow such an analysis, the number of Internet-ready computers per student may be used to help choose among schools with similar levels of student need after such student need has been established.

5) Under-performing schools:

The Tennessee Department of Education has designated some schools as "under-performing" based on student standardized test scores. Again, the survey sample was not large enough to allow an analysis of the effect of such a designation on computer and Internet usage. Under-performing schools, however, may be given preference among schools with similar levels of student need after such student need has been established.

Once schools have been identified, students that are most at-risk will be chosen for the program. Indicators of such risk include family income, the number of people in the household, the type of family living quarters, whether or not the household has a telephone, and the size of the student's residential area.

Establishing Criteria for Selecting Individual Candidates

Upon identification of the school sites for the pilot program, students will be selected to receive the donated computers. Objective criteria must first be established to prevent favoritism or abuse in the selection of program participants. The Department of Education and the participating schools should establish such criteria since they have the necessary expertise.

There are two options for distributing the computers within the participating schools.

Option 1:

Provide a computer for every student in the selected classroom who does not already have a home computer regardless of need or academic performance. The classroom could be selected based on the teacher's computer skills or interest in developing a curriculum around the computers. By providing computers to the entire classroom, the effectiveness of the trial may be measured by comparing the performance of the classroom with computers against the classrooms without computers. This option allows teachers to develop a curriculum around the computers and should enhance their productive use. The disadvantages are that some students who are not from low-income households may receive donated computers and that more computers may be needed.

Option 2:

Give computers to students based on income and other criteria established by educators. This option assures that only low-income students receive computers, allows the computers to be used as a reward or incentive, and allows computers to be assigned to multiple classrooms and grade levels. There are disadvantages to this approach. First, it will be more difficult to measure the effectiveness of the program because the participating students could vary by class and classroom. Second, it would be more difficult to develop a computer-based curriculum.

Regardless of which option is chosen, the whole point of placing the computers in students' homes is to also get the parents involved. In this pilot program, the parents would be required to come to school to take a class before their child's computer is delivered.

Strategy #2:

Obtain commitments from donors of computer equipment, software and Internet service providers sufficient to operate the pilot program.

The success of the pilot project depends first and foremost on procurement of personal computers. Locating corporations and/or agencies willing to donate computer hardware and software to the areas selected to participate is an important first step towards addressing the digital divide in the State. It is hoped that the corporations contacted will heed the comments of Bill Harrison, CEO of J.P.Morgan/Chase, who said when discussing the digital divide "My concern is that there's not enough corporate involvement in the education system. If there's any risk today, it's that corporate America is not engaged enough in the educational challenge."

After the list of potential donors has been established and grouped according to business type, the TRA will make arrangements to meet the appropriate person or persons within each targeted organization to discuss the program and associated donation opportunities. Persons functioning in the areas of corporate operations, community/corporate relations, or corporate philanthropy within the respective organizations are potential contacts.

Assuming that one (1) urban and one (1) rural school are selected from each Grand Division of the state, one hundred twenty (120) to one hundred fifty (150) computers will be needed to accurately measure the effectiveness of the pilot program.

From the view of the system requirements of several educational and business related software packages, minimum PC system requirements were developed that will allow for the basic execution of most major software titles. The sampled software included Microsoft Word 97 and 2000, Corel Word Perfect 8.0, MS Windows 95 and Windows 98 (OS), The Learning Company's Reader Rabbit Math and Reader Rabbit Reading, Knowledge Adventure's Jump Start software titles, Scholastic's software titles, Internet Explorer, Netscape, and Microsoft Works. Although roughly 50% of the software titles surveyed required minimums of an Intel 486DX processor, 16MB RAM, and (for non operating system software) 30MB of hard drive space, it is advised that the minimum be at the Pentium CPU.

The reasons for this recommendation are many and include:

- All software titles will execute on a Pentium-based computer.
- Pentium CPU's offer considerable gains in performance over 486 based computers, especially when executing complex software or using an Internet browser.
- Intel based computers have a wide installation base making availability of parts and support knowledge easier to obtain.
- Due to the size of the install base, it will be easier to find entities willing to donate computers of this type.
- A vast amount of software titles will execute on this platform.

Minimum specifications of the donated computers:

- Intel or Intel Celeron CPU
- Speed of P75 at minimum, preferred P166 or higher
- 32 MB System RAM
- 500MB hard drive, preferred 1GB or higher
- VGA video capable of 256 colors
- Quad speed (4X) CD-ROM
- Desktop or mini-tower, due to space, desktop preferred
- 15" SVGA monitor
- 16 bit sound card with headphones or speakers
- For Internet access, 28.8 modem, internal or external, prefer 33.6
- 2-button mouse, 101 keyboard

It should be noted that these are minimums only. Although this specification will execute most software titles, increased performance, productivity and overall enjoyment of the computer will be realized with increased component size and speed.

Strategy #3:

Establish a network of individuals or companies to provide delivery services, training, and/or technical assistance to the recipients.

Once commitments to provide the needed hardware and software are finalized, the TRA will make arrangements for delivery to the designated areas. Where the personal computers originate will likely determine how they are transported to the pilot project recipients. If a computer manufacturer provides the hardware, it is likely that the manufacturer will oversee delivery to the intended recipients. If the computers originate from a source other than an established manufacturer, it might be necessary to secure the voluntary assistance of a corporate delivery service, such as Federal Express or United Parcel Service, to facilitate the delivery services.

Concerning installation and training, there are three possible avenues worth investigating. The first involves the technical support branches of the manufacturers. Most, if not all, computer manufacturers of both hardware and software provide standard computer support for their systems. Secondly, support could be solicited from students at a local technical school in the community of the program recipients. As a final option, community volunteers could be enlisted to provide assistance from within the communities. The latter two options would be voluntary and would bring greater exposure to the digital divide issue as well as engendering a sense of community pride. As a potential fourth option, the designated school could have a staff member that could provide the support needed for operation of the systems.

Distribution of donated computers will have to be a coordinated effort among suppliers, transporters, installers, the schools, the Department of Education and the TRA. Once the schools for the pilot project are identified, installers in that area will need to be identified and delivery companies solicited to transport the donated computers to the installers. The program administrator could act as the coordinator of the distribution process. In this capacity, the administrator will serve as the main point of contact for the suppliers, transporters and installers.

Evaluation of the Pilot Program

Once the program has been put into place, it is important to follow-up with program evaluations that show whether or not the program has achieved its goals. Since the program will provide a computer, a donated Internet account, training, and technical support for all participants, most are likely at least to try using the Internet. Program goals should include a more rigorous test of effectiveness than simple Internet usage. Performance measures are derived directly from the objectives and will indicate the effectiveness of agency action. They are expressed in a quantifiable form and indicate the degree to which a program is achieving its objectives (i.e. measure ultimate result or effect of a service on customers). Evaluation criteria could include how students use the Internet, how many other household members begin accessing the Internet, and whether or not the student can use the Internet to research a subject and produce a report. Students who participate in the program, as well as their parents, will be required to agree to respond to baseline and follow-up questionnaires. In addition, participating students must agree to complete a small research project using the Internet if that is required for evaluation purposes.

Performance measures of both computer and Internet skills, which will be established for the pilot program by the Department of Education, will be developed as follows:

- Determine baseline performance
- Use benchmarks to establish performance targets
- Measure actual performance and report results
- Review and update performance measures.

Content Filtering

Computers in Tennessee schools access the Internet through an education portal designed for students. Questionable content is filtered out by this service before the information ever reaches Tennessee classrooms. Internet service for this pilot program will be donated, and it is not likely to be from the same provider. The TRA and the Department of Education cannot accept responsibility for content accessed by students in their homes. Parents will be trained in how to review the sites their children have visited on the Internet, and they will be informed of the existence of Internet content filtering software. There are a limited number of providers of such software, and households with both children and computers are a substantial part of their market, but it may be possible to find a corporate donor for this software as well.

Appendix A – House Resolution 0273 (Filed for intro on 06/06/2000)

HOUSE RESOLUTION 0273
By Hargrove

A **RESOLUTION** to direct the Tennessee Regulatory Authority to research, develop and formulate a program to facilitate access by underserved school-age children to technology-based information tools and advanced technology. **WHEREAS**, technology-based information tools, such as the personal computer and the Internet, are becoming increasingly critical to educational and economic advancement; and **WHEREAS**, the ability to effectively and efficiently employ this advanced technology is progressively essential for full participation in Tennessee's economic, political, and social life; and **WHEREAS**, there is a continuously growing divide between school-age children with access to these information tools and advanced technology and those children without such access; and **WHEREAS**, it is well-established and generally acknowledged that as information technology gains an ever-increasing role in our children's educational and economic lives certain children will be left behind in the information age with serious repercussions; and **WHEREAS**, the resulting digital divide threatens to impede the health of our communities, the development of a skilled workforce, and the economic welfare of our State; and **WHEREAS**, certain entities in both the private and the public sector have surplus technology related goods or excess capacity that could be contributed to and utilized by school-age children who otherwise lack direct and personal access to such advanced technology; and **WHEREAS**, this General Assembly finds that it is in the best and future interest of Tennessee to increase and expand access to information technologies for underserved populations and areas, and that the Tennessee Regulatory Authority should formulate a plan for a pilot program to facilitate access to educational technology by school-age children; now therefore, **BE IT RESOLVED BY THE HOUSE OF REPRESENTATIVES OF THE ONE HUNDRED FIRST GENERAL ASSEMBLY OF THE STATE OF TENNESSEE**, that the Tennessee Regulatory Authority is hereby directed, within existing resources, to research, develop and formulate a plan for a program whose purpose is to facilitate access, with the voluntary assistance and voluntary contributions of private industry and interested governmental entities, to information tools and educational technology by underserved school-age children. **BE IT FURTHER RESOLVED**, That the plan should serve as the basis and framework for a program, relative to advanced educational technology, through which the Authority may organize and facilitate a voluntary collaboration among private industry and federal, state and local governments whereby their goods and/or services may be contributed and utilized. **BE IT FURTHER RESOLVED**, that in developing the plan the Authority, shall consult with the Department of Education, the Department of Human Services and any other appropriate state agency, to develop criteria for determining the eligibility of underserved school-age children for this program and implementing the plan as a pilot program. Such pilot program shall provide for a selection of eligible candidates that is equally distributed between urban and rural areas and distributed equally among the grand divisions. **BE IT FURTHER RESOLVED**, that the Tennessee Regulatory Authority shall submit the plan, along with recommendations for implementing the plan, to the Speaker of the House, the Speaker of the Senate, and the Governor no later than March 15, 2001.

Appendix B – Major Studies on the Effectiveness of Computers as Learning Tools

Study	**Participants**	**Design and Methods**	**Findings**
Baker, E.L., M. Gearhart, & J.L. Herman. Evaluating the Apple Classrooms of Tomorrow. Technology Assessment in Education and Training. Hillsdale, NJ: Lawrence Erlbaum Associates, 1994.	First- through twelfth-graders	Series of evaluation studies over a three-year period. Students and teachers were given Apple computers in the classroom and at home. Comparison groups in neighboring areas were chosen. Study conducted in five school sites located in California, Ohio, Minnesota, and Tennessee.	• Apple Computers of Tomorrow (ACOT) had a positive impact on student attitudes. • Overall, ACOT students did not perform better on standardized tests.
Bangert-Drowns, R.L. The Word Processor as an Instructional Tool: A Meta-analysis of Word Processing in Writing Instruction. Review of Educational Research, Vol. 93, 1993, 63:63.	Elementary school age through college age	Meta-analysis based on 32 comparative studies measuring post-treatment performance criteria such as quality of writing, number of words, attitude toward writing, adherence to writing conventions, and frequency of revision.	• Small effect on improvement of writing skills • Studies that focused on word processing in the context of remedial writing yielded a larger effect.
Clements, D.H. Enhancement of Creativity in Computer Environments. American Educational Research Journal, Vol. 87m 1991, 28:173.	73 third graders (mean age 8 years, 8 months)	Pre-test, post-test design over a 25-week period. Children matched on creativity and achievement were assigned to 1) Logo software; 2) non-computer creativity training; 3) control. Study took place in New York.	• Children who worked with Logo had increased figural (non-verbal) creativity. • Both Logo and non-computer activities increased children's verbal creativity.

Study	Participants	Design and Methods	Findings
Elliott, A. & N. Hall. The Impact of Self-Regulatory Teaching Strategies on "At Risk" Preschoolers' Mathematical Learning in a Computer-Mediated Environment. Journal of Computing in Childhood Education, Vol. 98, 1997, 8:187.	54 pre-kindergarten students who were identified as at-risk of early learning difficulties	Children were placed into three groups. Two used computer-based math activities, and the third participated in non-computer-based math activities (and used computers for other areas). Study took place in Australia.	• Students in both groups that used computer-based activities scored significantly higher on the Test of Early mathematical Ability, TEMA 2.
Fletcher, J.D., D.E. Hawley & P.K. Piele. Costs, Effects and Utility of Microcomputer-Assisted Instruction in the Classroom. Paper presented at the 7th International Conference on Technology and Education. Brussels, Belgium, 1999.	Third- and fifth-graders	Students at each grade level received either computer-assisted instruction (CAI) or traditional math instruction for 71 days.	• At both grade levels, students receiving CAI scored higher on a test of basic math skills than those who received traditional instruction only.
Fletcher-Flinn, C.M. & B. Gravatt. The Efficacy of Computer-Assisted Instruction (CAI): A Meta-Analysis. Journal of Educational Computing Research, Vol. 42, 1995, 12:219.	Students from kindergarten through higher education	Meta-analysis of 120 studies conducted between 1987 and 1992. Looked at a range of factors including educational level, course content, publication year, duration of study, same or different teacher for the control group, and type of CAI.	• No significant differences in study results for any of the factors • Gains in proficiency linked with only one factor: the quality of CAI materials

Study	Participants	Design and Methods	Findings
Foster, K., et al. Computer-Administered Instruction in Phonological Awareness: Evaluation of the DaisyQuest Program. Unpublished paper.	Pre-kindergarten and kindergarten children; 25 in first study; 70 in second study	Pre-test, post-test design. Children randomly assigned to experimental group or control group. Experimental group received 16 to 20 sessions with DaisyQuest, a computerized program designed to increase phonological awareness.	• In two different studies, and on five different measures of phonological awareness, the computer-based approach was found to be more effective than regular instruction.
Gardner, C.M., et al. The Effects of CAI and Hands-On Activities on Elementary Students' Attitudes and Weather Knowledge. School Science and Mathematics, Vol. 36, 1992, 92:334.	Third graders	Comparative study of three groups in Georgia. First group received hands-on meteorology activities combined with software, second group received hands-on activities without software, third group received traditional classroom instruction.	• Children who had hands-on with software out-performed those who had hands-on without software. • Both groups scored higher than those who had traditional instruction.
Kulik, J.A. Meta-Analytic studies of Findings on Computer-Based Instruction. In Technology Assessment in Education and Training. Hillsdale, NJ: Lawrence Erlbaum Associates, 1994.	Students from kindergarten through higher education	Meta-analysis of more than 500 individual studies of computer-based instruction.	• Students who used computer-based instruction scored higher on achievement tests, learned in less time, and were more likely to develop positive attitudes.

Study	Participants	Design and Methods	Findings
Kulik, C. & J.A. Kulik. Effectiveness of Computer-Based Instruction: An Updated Analysis. Computers in Human Behavior, Vol. 94, 1991, 25:366.	Students from kindergarten through higher education.	Meta-analysis of 254 controlled-evaluation studies	• Computer-based instruction had a "moderate but significant" positive effect on achievement.
Lazarowitz, R. & J. Huppert. Science Process Skills of 10th Grade Biology Students in a Computer-Assisted Learning Setting. Journal of Research on Computing in Education, Vol. 82, 1993, 25:366.	High school students	Pre-test, post-test design over four weeks in five biology classes in Israel. The experimental group received classroom laboratory instruction that included use of a software program. The control group received classroom instruction only.	• Experimental group achieved higher mean score on the post-test. • No significant differences between the groups by gender.
Mann, D., et al. West Virginia's Basic Skills/Computer Education Program: An Analysis of Achievement. Santa Monica, CA: Milken Family Foundation, 1999.	Representative sample of 950 fifth-graders from 18 elementary schools	Study of students who used Basic Skills/Computer education program in West Virginia. Several variables were analyzed, including intensity of use, prior achievement sociodemography, teacher training, and teacher and student attitudes.	• The more students participated in the program, the more their test scores improved. • Consistent access, positive attitudes toward the equipment, and teacher training in the technology led to the greatest achievement gains.
Mayfield, Stewart C., et al. Evaluation of Multimedia Instruction on Learning and Transfer. Paper presented at the Annual Conference of the American Education	At-risk, inner-city kindergartners	Children exposed to a multimedia environment (Multimedia Environments that Organize and Support Text) for language development for three months were compared	• Study group members showed superior gains in auditory skills and language skills, were able to tell stories better, and showed better use of tense.

Study	Participants	Design and Methods	Findings
Research Association. New Orleans, 1994.		with children in a conventional kindergarten classroom.	
Raghaven, K., M.L. Sartoris, & R. Glaser. The Impact of Model-Centered Instruction on Student Learning: The Area and Volume Units. Journal of Computers in Mathematics and Science Teaching, Vol. 4, 1997, 16:363.	110 sixth-graders (50 boys and 60 girls)	Eight-week curriculum to teach students in Pennsylvania concepts of area and volume using a computer-based program in addition to traditional instruction. At the end of the course, students were tested and their scores compared with eighth-graders who had received traditional instruction only.	• Computer-based program increased students' reasoning skills • The sixth-grade students scored better overall than the eighth-grade students, especially on more complex problems
Ryan, A.W. Meta-Analysis of Achievement Effects of Microcomputer Applications in Elementary Schools. Educational Administration Quarterly,Vol. 84, 1991, 27:161.	Elementary school children (grades K-6); each study with a sample size of at least 40	Meta-analysis of comparative studies. Variables analyzed included characteristics of students, teachers, physical settings, and instructional formats.	• Amount of technology-related teacher training significantly related to achievement of students
Scardamalia, M., et al. Computer-Supported Intentional Learning Environments. Journal of Educational Computing Research, Vol. 68, 1989, 5:51.	Fifth- and sixth-graders	Students worked with a collaborative computer application, Computer Supported intentional Learning Environment (CSILE) daily for almost eight months.	• Independent thinking, student reflection, and progressive thought were maximized by CSILE.

Study	Participants	Design and Methods	Findings
Schultz, L.H. Pilot Validation Study of the Scholastic Beginning of Literacy System (Wiggle Works). 1994-'95 Mid-Year report. Unpublished paper. February, 1995.	First-graders	Three-month study in two suburban systems (California and Massachusetts) and one urban system (Massachusetts), in which the study group used interactive storybooks in addition to traditional instruction to support reading, writing, speaking and listening; control group received traditional instruction only.	• Study group demonstrated an increase in basic language skills
Stone, T.T., III. The Academic Impact of Classroom Computer Usage upon Middle-Class Primary Grade Level Elementary School Children. PhD Dissertation, 1996. Abstract in Dissertation Abstracts International: 57/06-A	114 second-graders	Students the same age, same socioeconomic status, and using the same curriculum were compared across two schools in the same district. One group used computer-assisted instruction (CAI); the other did not.	• Children who used CAI since kindergarten achieved a significant improvement in vocabulary, reading, spelling, and math problem-solving achievement.
Wenglinsky, H. Does It Compute? The Relationship Between Educational Technology and Student Achievement in Mathematics. Princeton, NJ: Educational Testing Service, 1998.	Fourth- and eighth-graders	National assessment of the effects of simulation and higher-order thinking technologies on math achievement. Data analyzed controlling for socioeconomic status, class size, and teacher characteristics.	• Students who used the software showed gains in math level • Students whose teachers received training showed gains in math scores

This information, with a few presentation adjustments, was presented in an appendix to:
Roschelle, J.M., et al. "Changing How and What Children Learn in School with Computer-Based Technologies," *The Future of Children*, Vol. 10, No. 2, Fall/Winter 2000, p. 76-101.

Appendix C - TRA Survey Methodology

The TRA survey was conducted by the Center for Business and Economic Research at the College of Business Administration and the Social Science Research Institute, both at the University of Tennessee, Knoxville. The survey was conducted by telephone, between October 25 and December 2, 2000, using a Computer Assisted Telephone Interviewing System that utilized a random-digit dialing based sample. Four calls were made to each residence, at staggered times, to minimize non-respondent bias. The design used was a "Household Sample," with the interview conducted with the Head of the Household. The University of Tennessee Social Science Institute administered the survey.

Approximately 60% of those contacted agreed to participate in the survey, a relatively high response rate. The demographics also very closely mirrored those for the state obtained from the most recent census estimates. The proportion of households with incomes under $10,000 per year were, however, underrepresented in the sample because the lowest income Tennessee residents are the least likely to have telephones. The large sample allowed the weighting of responses of low income Tennesseans to provide unbiased estimates for the entire population of the state.

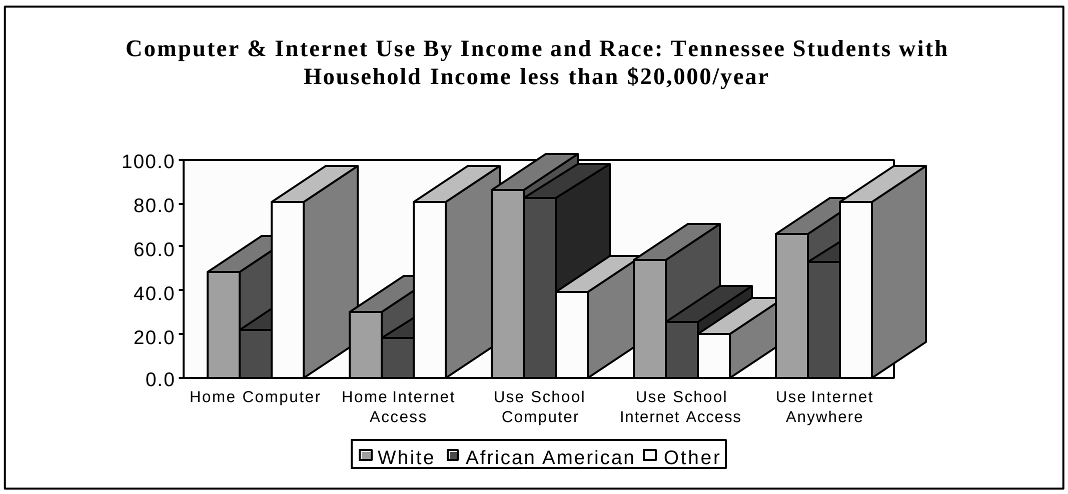
The weighting scheme used multiplied the number of people in each category times the following weights to make the sample accurately represent Tennessee's income distribution:

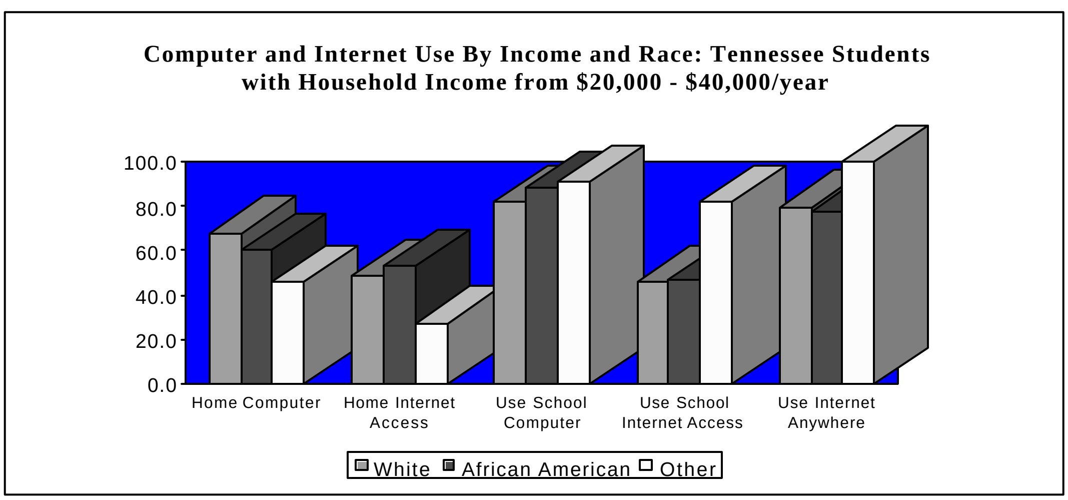
Annual Household Income	Weight
Less than $10,000	4.98
$10,000 - $19,999	2.42
$20,000 - $29,999	1.72
$30,000 - $39,999	1.15
$40,000 - $49,999	0.63
$50,000 - $59,999	0.55
$60,000 - $74,999	0.56
$75,000 or above	0.31

The final sample included 1,200 households. A portion of the survey, designed to produce individual information on each child (up to six children per household), was completed for 2,037 children. A copy of the survey is available on the TRA web site at www.state.tn.us/tra.

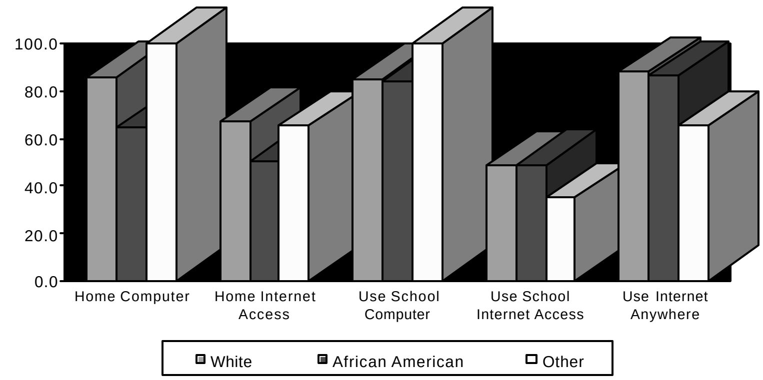
Appendix D – Computer and Internet Usage by Income and Other Demographic Categories

Though income is at the root of many of the access differences among different groups, it is not the only access gap that exists in Tennessee. Even when children from households with like incomes are compared, racial differences emerge. The use of computers and the Internet in schools closes the gaps somewhat, but they still exist. The gaps in usage, especially home usage, are most pronounced at lower income levels. As incomes increase, the racial gaps appear to close in school computer and school Internet access, but gaps in home computer ownership and home Internet access still exist, even at the higher income levels. Because Tennessee has a very small proportion of its population in Hispanic, Native American and Asian racial categories, most of the samples in the "other" race category were a bit too small at this level of subdivision to provide reliable information.

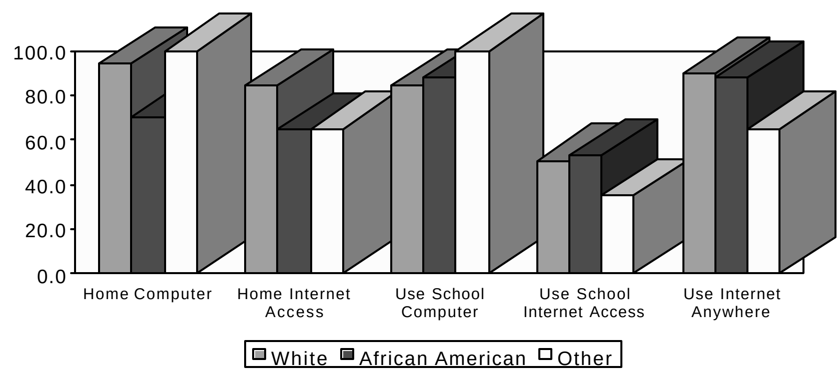




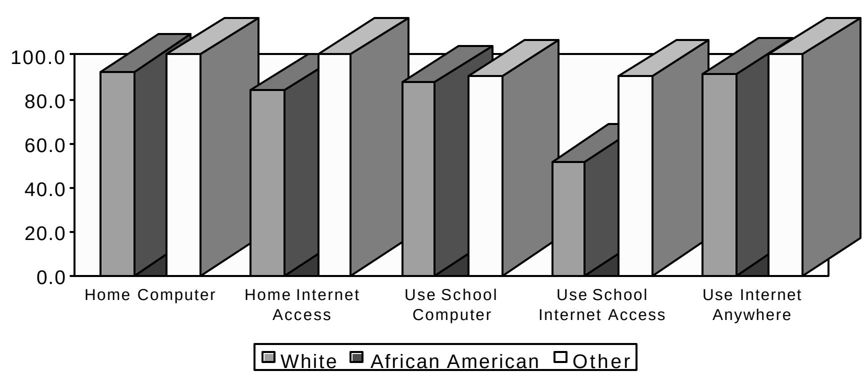
Computer and Internet Use By Income and Race: Tennessee Students with Household Incomes from $40,000 - $60,000/year



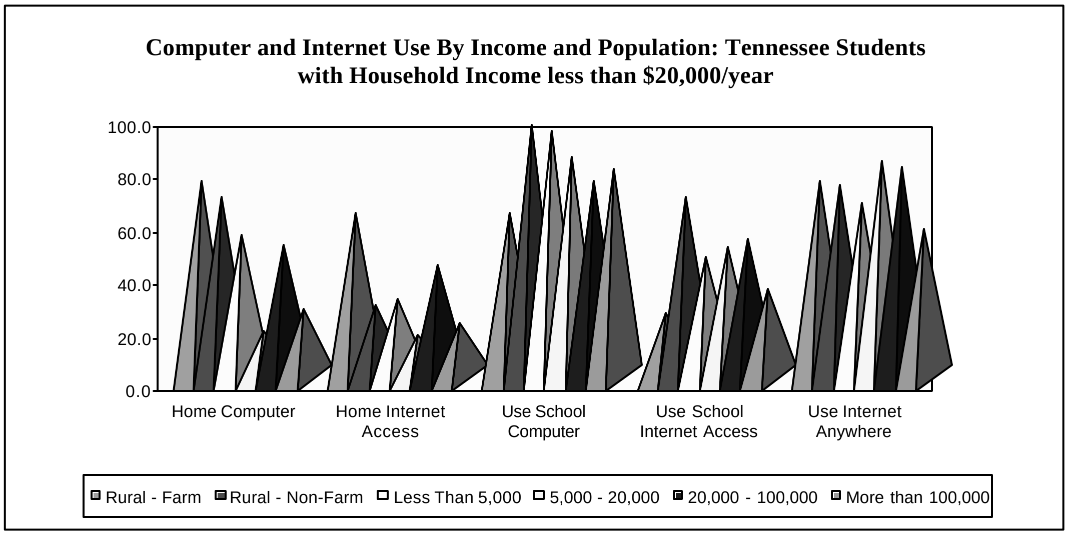
Computer and Internet Use By Income and Race: Tennessee Students with Household Income from $60,000 - $75,000/year

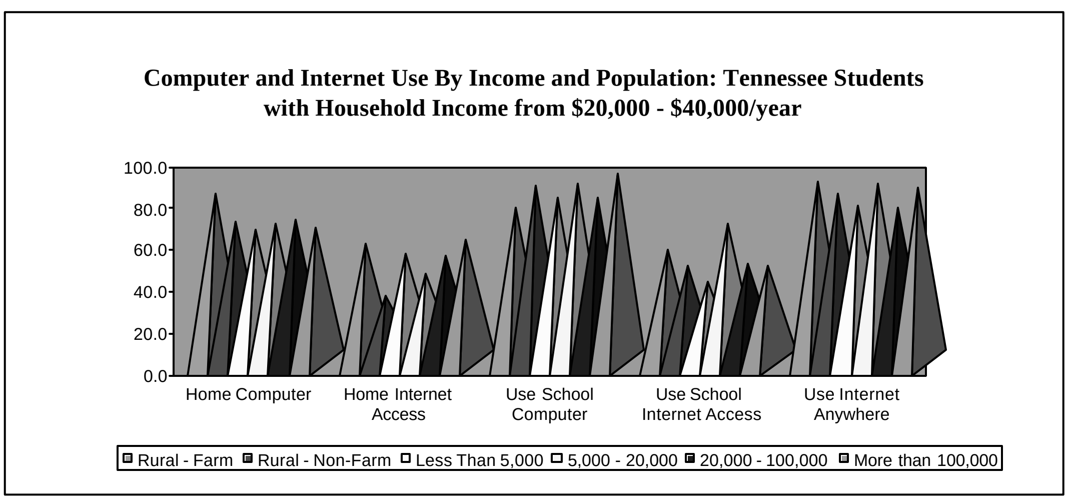


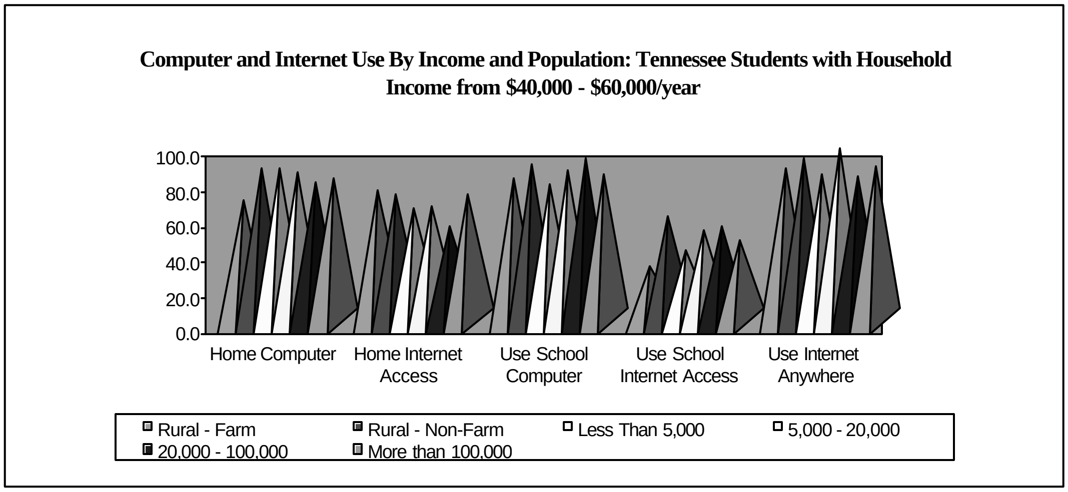
Computer and Internet Use By Income and Race: Tennessee Students with Household Income more than $75,000/year

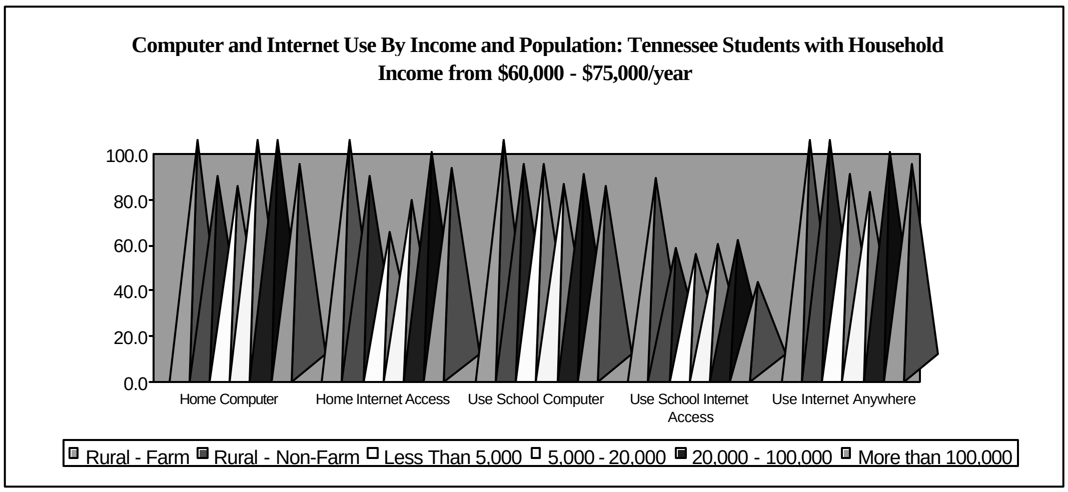


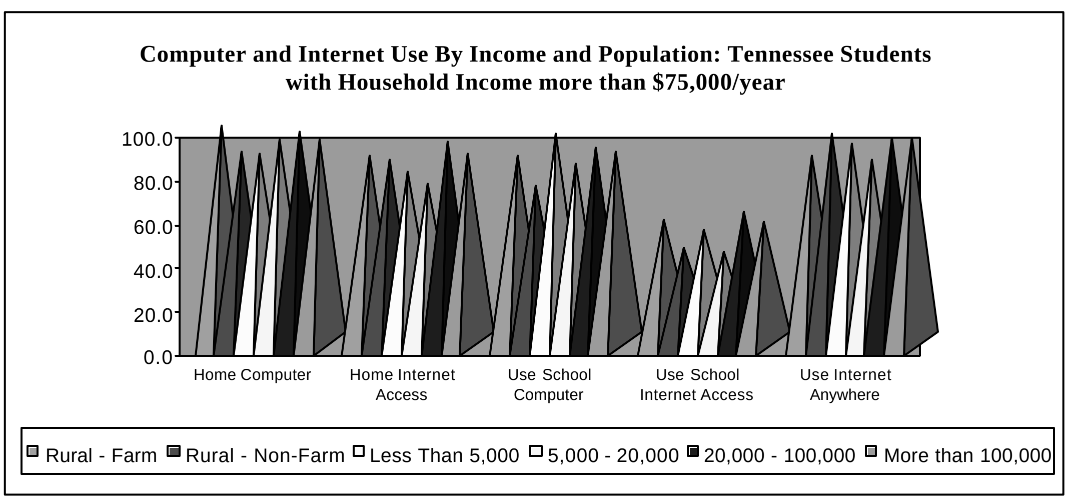
Just as they did when subdivided by race and income, the access gaps among children who live in areas with differing population densities get smaller as incomes get larger. Those gaps did not disappear completely at higher income levels in the race comparisons, and the gaps still exist even at the highest levels of income in population density comparisons. At lower income levels, the access divide among children in areas with varying population densities is quite significant. Children in rural non-farm areas, very small towns and central cities tend to lag behind children on farms and those in larger cities and suburbs. These gaps are especially marked at lower income levels. As access levels out in schools, some of the divide disappears. As these graphs show, however, equal in-school access does not necessarily translate into equal overall access. Even when school access is flat across demographic divisions, home access and "anywhere" access are not.





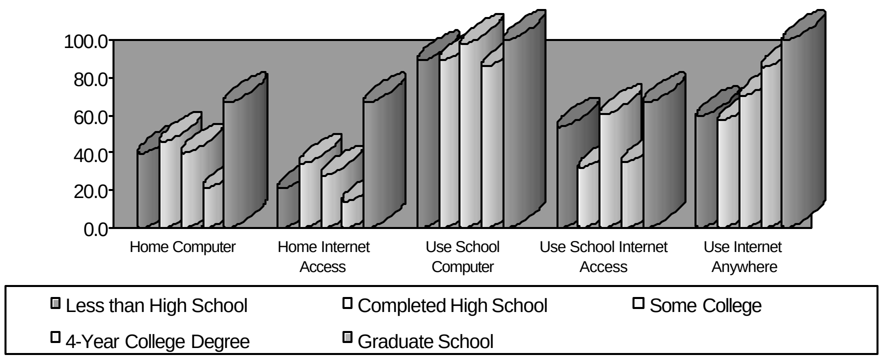

Computer and Internet Use By Income and Population: Tennessee Students with Household Income from $40,000 - $60,000/year
100.0
80.0
60.0
40.0
20.0
0.0
Home Computer
Home Internet Access
Use School Computer
Use School Internet Access
Use Internet Anywhere
Rural - Farm
Rural - Non-Farm
Less Than 5,000
5,000 - 20,000
20,000 - 100,000
More than 100,000


Computer and Internet Use By Income and Population: Tennessee Students with Household Income from $60,000 - $75,000/year
100.0
80.0
60.0
40.0
20.0
0.0
Home Computer
Home Internet Access
Use School Computer
Use School Internet Access
Use Internet Anywhere
Rural - Farm
Rural - Non-Farm
Less Than 5,000
5,000 - 20,000
20,000 - 100,000
More than 100,000

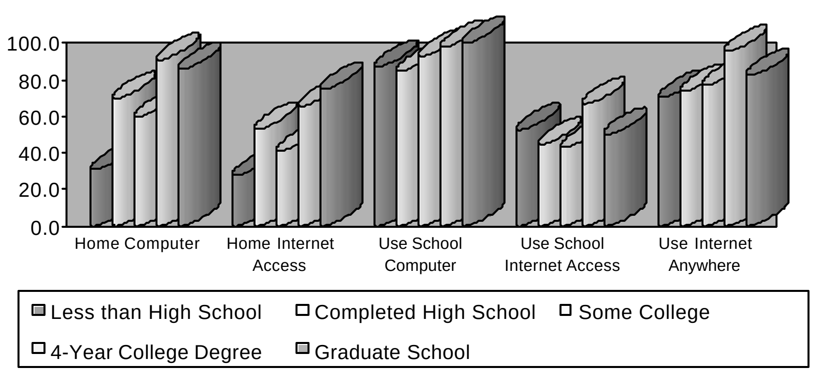

Computer and Internet Use By Income and Population: Tennessee Students with Household Income more than $75,000/year
100.0
80.0
60.0
40.0
20.0
0.0
Home Computer
Home Internet Access
Use School Computer
Use School Internet Access
Use Internet Anywhere
Rural - Farm
Rural - Non-Farm
Less Than 5,000
5,000 - 20,000
20,000 - 100,000
More than 100,000

In the “less than $20,000/year” household income bracket, school computer use is nearly even across education categories, but home computer ownership and home Internet access vary somewhat. The relationship between head of household educational attainment with income held constant and technology access is only consistent within the “use the Internet anywhere” category. It is difficult to draw too many conclusions from the high education/low income and low education/high income combinations, because the samples in those categories are very small. Not many people with four-year college degrees earn less than $20,000/year. Likewise, not many people with less than a high school diploma earn $75,000+/year. In the mid-income levels and in the mid-education levels, samples are large enough to draw some conclusions.

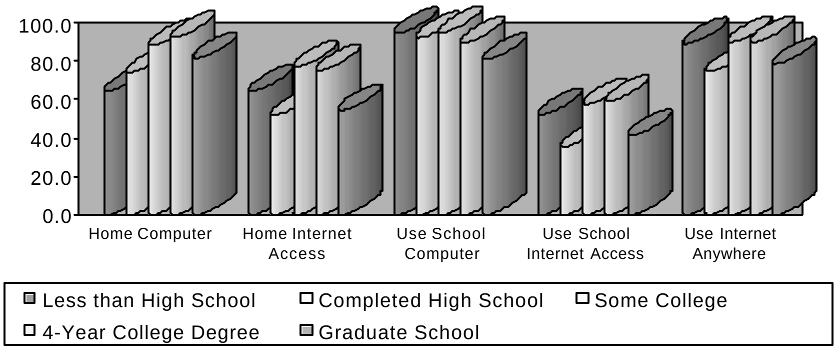
Computer and Internet Use By Income and Head of Household Educational Attainment: Tennessee Students with Income less than $20,000/year



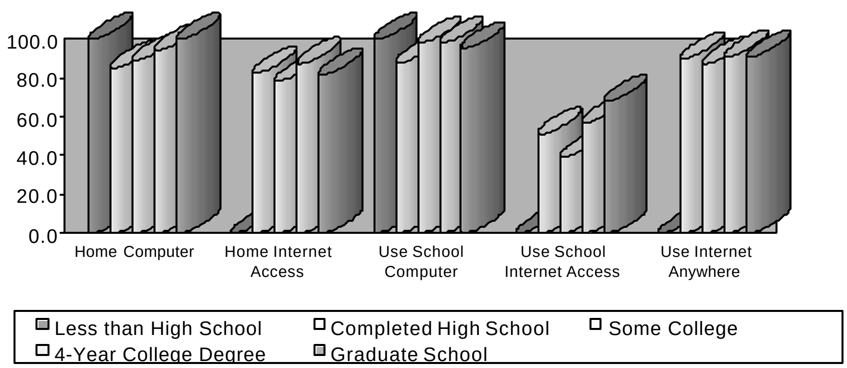
Computer and Internet Use By Income and Head of Household Educational Attainment: Tennessee Students with Income from $20,000 - $40,000/year



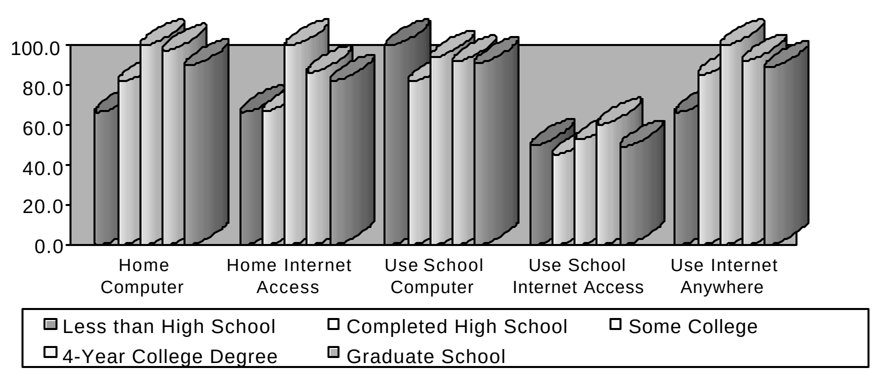
Computer and Internet Use By Income and Head of Household Educational Attainment: Tennessee Students with Income from $40,000 - $60,000/year



Computer and Internet Use By Income and Head of Household Educational Attainment: Tennessee Students with Income from $60,000 - $75,000/year



Computer and Internet Use By Income and Head of Household Educational Attainment: Tennessee Students with Income more than $75,000/year



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